Hebgen Reservoir Creel Survey and Contribution of Stocked Rainbow Trout to the Recreational Fishery: June 2000 to June 2001

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ABSTRACT

Hebgen Reservoir provides a popular fishery for Southwest Montana. While wild rainbow and brown trout are the basis for the fishery, Montana Fish, Wildlife, and Parks (FWP) annually stocks approximately 100,000 Eagle Lake strain rainbow trout. The management goal for the Hebgen Reservoir fishery is to establish a self-sustaining trout fishery. However, little was known about the contribution of hatchery rainbow trout to the angler's creel. This creel survey was designed to quantify angling pressure, catch rates, angler characteristics, and to better define contribution of hatchery rainbow trout to the creel. For the period from June 12, 2000 to June 10, 2001, we estimated fishing pressure to be 64,811 angler hours, concentrated from May to August. Catch rates of rainbow trout averaged 0.31 per hour, which were considerably higher than the estimated 0.09 brown trout caught per hour. Mountain whitefish and Utah chub are common in the reservoir, but rarely caught by anglers. Total harvest was estimated to be between 9,303 and 11,345 rainbow trout and from 2,958 to 3,571 brown trout.

Rainbow and brown trout caught by anglers were of similar average length and weight, averaging 16.4 inches, 1.45 lbs and 16.1 inches, 1.54 lbs, respectively. Age 3 and 4 rainbow and brown trout comprised 68% of trout in the creel. In general, hatchery rainbow trout grew slightly faster than wild rainbow trout, but wild rainbow live longer. Age 1 rainbow trout were rare in the creel and in gill nets, suggesting that wild rainbow rear in tributaries. Only hatchery age 1 rainbow trout were in the creel.

Rainbow trout origin was difficult to assess. We used dorsal fin erosion, presence of a "stocking-check" on scales, and tetracycline marks to indicate whether or not rainbow trout were of hatchery origin. Each method had biases and results ranged from 30% by dorsal fin erosion to 3% by tetracycline marks. Scale analysis was the most subjective, estimating that 47% of rainbow trout were of hatchery origin.

ACKNOWLEDGEMENTS

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INTRODUCTION

Hebgen Reservoir provides a popular sport fishery in Southwest Montana, ranking 15th in angling pressure exerted statewide in 2001 (Fig. 1, McFarland and Meredith 2002). Hebgen Dam was completed and the reservoir was filled in 1915. At full pool elevation of 6,534 feet the reservoir covers 12,668 surface acres. Wild, self-sustaining brown trout (*Salmo trutta*) and rainbow trout (*Oncorhyncus mykiss*) are the current mainstays of the fishery, with supplementation by annual plants of approximately 100,000 young-of-the-year (fry) Eagle Lake strain rainbow trout. Native mountain whitefish (*Prosopium williamsoni*) also provide a component of the fishery. Utah chub (*Gila atraria*), illegally introduced circa 1935, predominate the biomass of fish in Hebgen Reservoir (Leik 1978, Byorth and Weiss 2002).

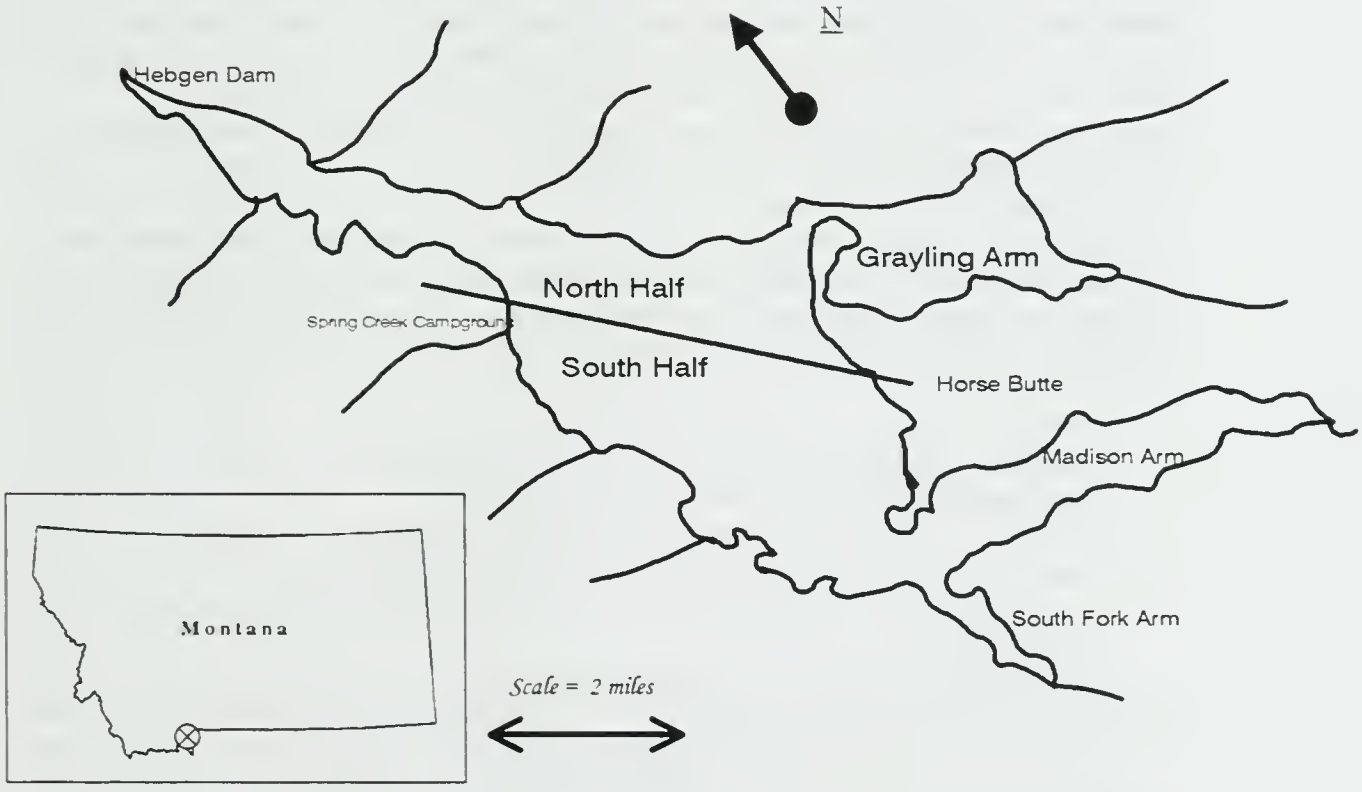

Figure 1. Map of Hebgen Reservoir, MT. The line across the reservoir represents the delineation between the North and South halves for the June 2000 to June 2001 creel survey.

In 1979, Montana Fish, Wildlife & Parks (FWP) adopted a new management focus for Hebgen Reservoir based on a wild, self-sustaining fishery (Hetrick 1994). In pursuing this objective, stocking practices shifted to using wild strains of rainbow trout (DeSmet and Eagle Lake strains) and Yellowstone cutthroat trout (*O. clarki bouveri*) in hopes of enhancing spawning runs and recruitment to the fishery (Hetrick 1994). However, reducing or eliminating stocking without understanding the contribution hatchery rainbow trout provide to the fishery could have undesirable impacts on fishing success and create controversy.

The relative contribution of wild versus hatchery-reared rainbow trout to the Hebgen Reservoir fishery and creel has been difficult to assess. Oswald et al. (1990) reported that a "stocking check" was apparent on scales from fishes of hatchery origin. On that basis, Oswald et al. (1990) estimated that 69% of rainbow trout sampled in Fall 1989 on Hebgen Reservoir were of hatchery origin. Fredenburg (1991) investigated spawning runs in tributaries of Hebgen Reservoir and estimated that 590,000 rainbow trout fry emigrated to the reservoir from its tributaries. Since 1990, gill netting has been the predominant sampling method to determine relative abundance of the rainbow trout population in Hebgen Reservoir. Hetrick (1994) reported a relationship between the number and strain of rainbow trout planted with gill net catch as well as angler satisfaction. However, gill net catches have varied considerably since 1994 in spite of consistent stocking rates (Byorth and Weiss 2002).

The relationships between wild rainbow trout recruitment, hatchery supplementation and angler success have not been established. To characterize the fishery and analyze relative contribution of hatchery and wild rainbow trout to the creel, a comprehensive creel survey was conducted from June 2000 to June 2001. The objectives of the creel survey were:

1. Estimate the amount of fishing pressure exerted at Hebgen Reservoir over a twelve month period
2. Calculate angler catch-per effort and harvest for each species in the fishery
3. Document the size and age distribution of fish creeled by anglers
4. Assess the relative contribution of hatchery-reared and wild rainbow trout creeled by anglers and
5. Characterize anglers fishing at Hebgen Reservoir.

METHODS

Fishing Pressure Estimates

Fishing pressure was estimated via direct angler counts. Creel clerks counted boat anglers, shore anglers, and non-motorized boats (including float tubes) and recorded counts on a form (Appendix A). To be valid "instantaneous" counts, they were to be completed within a one-hour period (Neuhold and Leu 1957). Counts were conducted on randomly selected dates stratified in two-week periods (strata), beginning June 12, 2000 ending June 10, 2001 (Appendix B). In order to adequately sample Hebgen Reservoir, it

was divided into North and South sections with the boundary approximated by a line from Watkins Point to "Chub Beach" on the Horse Butte Peninsula (Fig. 1).]

Within each stratum during the summer creel (June 12 through October 15, 2000), 5 weekdays and two weekend days were selected at random. On each count date, anglers were counted in either the morning (6am to 2pm) or evening (2pm to 10pm), also selected at random. The summer creel survey involved two creel clerks from June 12 – August 24, 2000, and a single clerk thereafter. Two starting times were selected for counts at random within the morning or evening sampling period (i.e. 6 or 7 am, or 2 or 3 pm). Counts began on either the North or South half, selected at random. The second count alternated to the opposite half 2 hours later. Thus, on a given day, counts could begin at 6am North, 8am South, 10am North, and 12pm South. On the North side, a clerk counted anglers from Highway 287 at designated pull-offs from Hebgen Dam to the Grayling Creek Narrows (or vice versa), using a spotting scope or binoculars (Fig. 1). When available, the second clerk counted anglers in the Grayling Arm from Horse Butte to Rainbow Point (Fig. 1). Alternately, anglers were counted on the south side from the Madison arms to Edwards Peninsula from the Horse Butte Road. The other clerk counted from the South Fork Arm to Spring Creek Campground.

During the winter creel (October 16, 2000 – March 4, 2001) a single creel clerk counted anglers one weekend day and three weekdays per two-week stratum. Either the North or South half was selected for the first count until the South half became inaccessible at the end of the October 16 – 29, 2000 stratum. Beginning October 30, 2000, the creel clerk would count only the North side except on a single count date per stratum, when they would count the South side exclusively, by snowmobile. During the winter creel, counts began at either 8 or 9am, chosen at random. During late winter creel (March 5 – April 29, 2001), count times returned to either morning or evening start times on a single weekend day and 4 weekdays per stratum, with a single weekday dedicated to counting the South half. Spring creel (April 30 – June 10, 2001) returned to count schedules similar to the summer creel: a single creel clerk, counting the North and South halves alternately, on two weekend days and 4 weekdays per stratum.

Angler Interviews:

Catch and creel information and angler characteristics were surveyed by conducting interviews with anglers. During non-count hours, clerks attempted to interview anglers at marinas and key access points or via boat. Questions included: number of anglers in party; time fishing began, ended, and whether trip was completed; hours fished; angler origin (Montana county, or state of origin); number of fish caught, kept, and released, by species; whether they fished from shore, boat, or non-motorized boat; fishing method and terminal tackle; and target species (form in Appendix C).

Clerks requested permission to measure and weigh each creeled fish, identified species, collected scale samples, and offered to dress rainbow trout in exchange for collecting vertebrae, which allowed determination of hatchery or wild origin. A single vertebra was collected from each rainbow trout immediately posterior to the cranium. The clerks noted their judgment as to whether a rainbow trout was wild or hatchery-reared based on

dorsal fin erosion. A rainbow trout was considered to be of hatchery origin if its dorsal fin showed a frayed or malformed appearance, especially on the distal ends of the first few fin rays. Each fish was identified with a unique number which was recorded on the data sheet, scales sample envelope, and a vertebrae sampling envelope for rainbow trout.

Analysis

Each data set was keypunched into Microsoft Excel spreadsheets. Count and interview data were used to calculate fishing pressure (angler-hours and angler days), catch rates, and harvest according to equations detailed in Neuhold and Leu (1957) and analyzed in Montana Fish Wildlife and Parks Creel Census Program (McFarland and Roche 1987).

Fishing pressure, catch rates, and harvest were calculated for each stratum by section (North or South half) and pooled by calendar month for further analysis. Other data sets were analyzed using Excel or Statistix 7.0 (Analytical Software 2000).

During the summer creel strata (June 12 to September 30), a miscommunication resulted in clerks only recording interviews with successful anglers. Because of the obvious bias created by omitting unsuccessful anglers, four data sets were developed:

1. Base: Included ***all*** actual interviews with successful anglers from June 12 – September 30, 2000 and all (successful and non-successful anglers) interviews thereafter
2. Edits: Included only ***completed*** interviews with successful anglers from June 12 – September 30, 2000 and all actual (successful and non-successful anglers) interviews thereafter
3. Editshigh: Included ***completed*** interviews with successful anglers from June 12 – September 30, 2000 ***and projected*** non-successful angler interviews based on recorded party sizes with clear references to other anglers, and all actual (successful and non-successful anglers) interviews thereafter and
4. Highbase: Included ***all*** interviews with successful anglers from June 12 – September 30, 2000, ***all projected*** non-successful angler interviews based on recorded party sizes, and all actual (successful and non-successful anglers) interviews thereafter.

To ensure that bias was minimized, each dataset was analyzed separately. Pressure estimates (angler hours) were independent of datasets (Chi-square =0.89, p=0.64). Catch rates and harvest each varied between data sets due to different interview outcomes. These results were compared using Chi-Square Association tests, ANOVA, and t-tests to determine whether results varied significantly and to choose the least biased estimate for further analysis and reporting.

Analysis of Rainbow Trout Origin

Creel clerks collected scales from each fish sampled. Up to three scales were mounted on acetate film and pressed in a heated hydraulic press to create impressions. Age of fish was determined by viewing acetate plates under a Microfiche projector as described by

Mackay et al. (1990). I also attempted to classify origins of rainbow trout (hatchery vs. wild) by following procedures reported in Oswald et al. (1990). They reported that hatchery fish "showed a strong 'stocking check' on the scales, generally about 8 circuli out from the focus" (Oswald et al. 1990). Using this as a guideline, I reclassified the same scales used by Oswald et al. (1990) and compared their results to mine. My results concurred with previously reported classifications in 75% of scale samples. Each scale set collected by creel clerks was similarly classified and results were compared to creel clerk's classification by fin erosion and to results of tetracycline marks in rainbow trout when a vertebra was collected.

Since the mid-1990's, all rainbow trout stocked into Hebgen Reservoir have been exposed to oxy-tetracycline in the hatchery to create a mark in bony structures. Vertebrae were collected by creel clerks, dried, cleaned of tissue, and held under a black light to detect marks. A positive "tet-mark" is a ring that glows under black light. Thus, each trout's length, weight, fin erosion, tet-mark, and age were recorded and tabulated. Unique identification codes assigned to each fish enabled comparisons of methods for a given fish.

RESULTS

Fishing Pressure Estimates

Fishing pressure was highest between May and August (Fig. 2). Of the 64,811 angler-hours estimated for the creel period, 80% occurred during these late spring and summer months (Table 1). The winter fishery was limited, although February supported over 2,500 angler hours of ice fishing pressure. However, during winter months the South half of the reservoir was inaccessible except by snowmobile and sampled on a limited basis. Limited winter counts of the south half may have biased winter pressure estimates.

Over the course of the entire creel period, angling pressure was evenly distributed between the North and South halves (46.5% and 53.5%, respectively, Fig. 2). However, pressure exerted by shore (including ice fishing) and boat anglers differed between the two sections. The North half of the reservoir received 40.5% of the pressure by shore anglers, while 59.5% was boat anglers. On the South side, with more limited shore access, boat anglers dominated pressure 82.2% to 17.8% by shore anglers. Over both sections and the entire period, boat fishing comprised 71.6% of all fishing pressure. About 25% of total shore fishing pressure could be attributed to ice fishing.

Fishing Catch-per-Effort and Harvest

Analysis of catch rates and harvest was made difficult by creel clerks failing to record trips of non-successful anglers from June through September 2000. Of the four data sets created, catch rates varied between data sets for rainbow trout but harvest was similar between data sets (ANOVA; $p=0.5262$). For brown trout, neither catch rates (ANOVA; $p=0.0847$) nor harvest (ANOVA; $p=0.99385$) varied significantly among datasets.

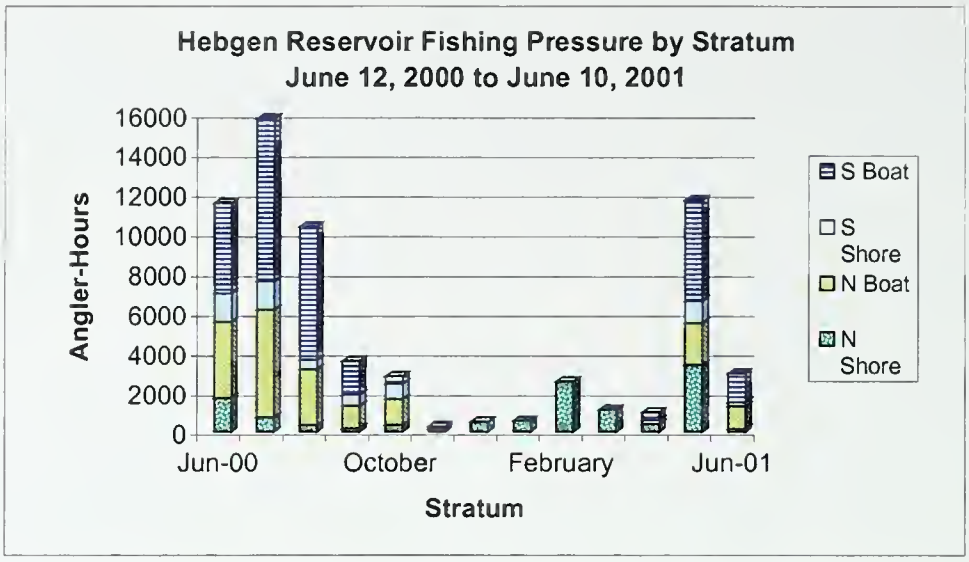

Figure 2. Histogram representing fishing pressure on Hebgen, Reservoir, Montana, by stratum (June 12, 2000 to June 10, 2001), by North (N) or South (S) half, and shore or boat.

Table 1. Fishing pressure exerted on Hebgen Reservoir, Montana, between June 12, 2000, and June 10, 2001, by stratum.

Stratum	Estimated Pressure	95% Confidence Interval
6/12 – 6/30/00	11,533	2,884
7/01 – 7/31/00	15,843	3,270
8/01 – 8/31/00	10,363	3,240
9/01 – 9/30/00	3,570	1,259
10/01 – 10/31/00	2,795	885
11/01 – 11/30/00	283	178
12/01 – 12/31/00	508	235
1/01 – 1/31/01	581	347
2/01 – 2/28/01	2,556	1,111
3/01 – 3/31/01	1,139	462
4/01 – 4/30/01	986	632
5/01 – 5/31/01	11,692	3710
6/01 – 6/10/01	2,963	816

However, catch rates and harvest are reported for two datasets: Edits (including only completed trips) and Editshigh (including completed trips and projected non-successful anglers).

For rainbow trout catch rates, significant differences were detected among all four datasets (ANOVA; $p=0.0001$). However, no significant differences were detected between Base and Edits (t-tests; $p=0.093$) nor between Editshigh and Highbase (t-tests;

p=0.784). Therefore, the Base and Highbase datasets were excluded from further analysis. Rainbow trout catch rates for datasets Edits and Editshigh were significantly different (t-tests; p=0.0025). I report catch rates from both sets because of the upward bias created by excluding unsuccessful anglers (Edits) and downward bias by projecting unsuccessful anglers (Editshigh). However, the Editshigh dataset was considered the least biased and most precise.

In general, rainbow trout catch rates were much higher than brown trout, although long-term gill net catch per effort is similar between species (Byorth and Weiss 2002). Over the whole reservoir for all strata, rainbow trout were caught at an average rate of 0.31 per hour. Brown trout catch rates averaged 0.09 per hour. Mountain whitefish and Utah chub are quite common in the reservoir but were caught at low rates. Mountain whitefish catch rates averaged 0.02 per hour over the entire creel survey, while Utah chub were only caught at a rate of 0.03 per hour.

Rainbow trout catch rates varied between the North and South halves of the reservoir (Fig. 3). While catch rates for rainbow trout peaked at higher rates on the South side, rates were more consistent on the North side, ranging from 0.2 to 0.4 per hour. Highest catch rates on the South side were recorded during strata in which ice melted and formed. Brown trout catch rates were also generally lower on the North side and the best catch rates were recorded during ice melt and formation (Fig. 4).

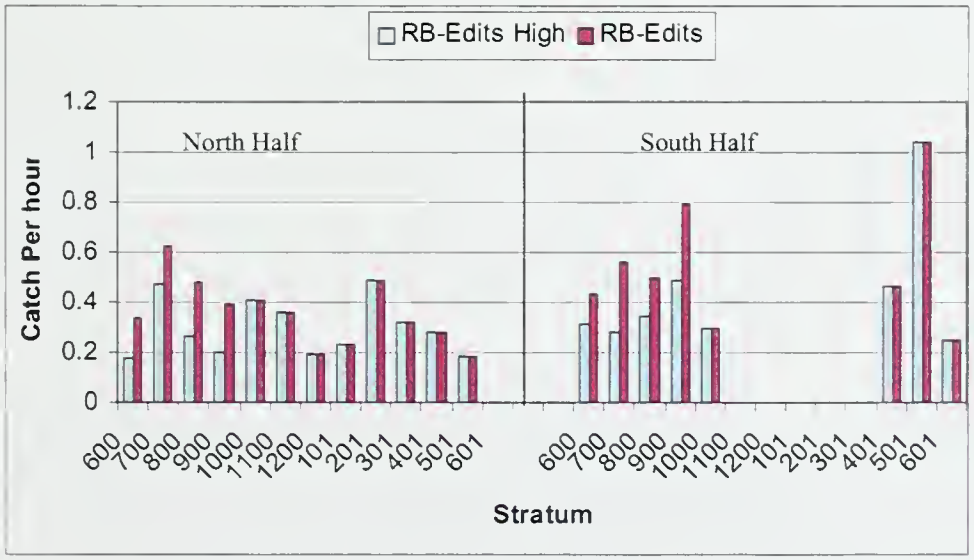

Figure 3. Summary of catch per hour of rainbow trout (RB), by two analysis methods in the North half (left bar cluster) and South half (right bar cluster) of Hebgen Reservoir during creel survey by stratum from June 12, 2000 ("600") to June 11, 2001 ("601").

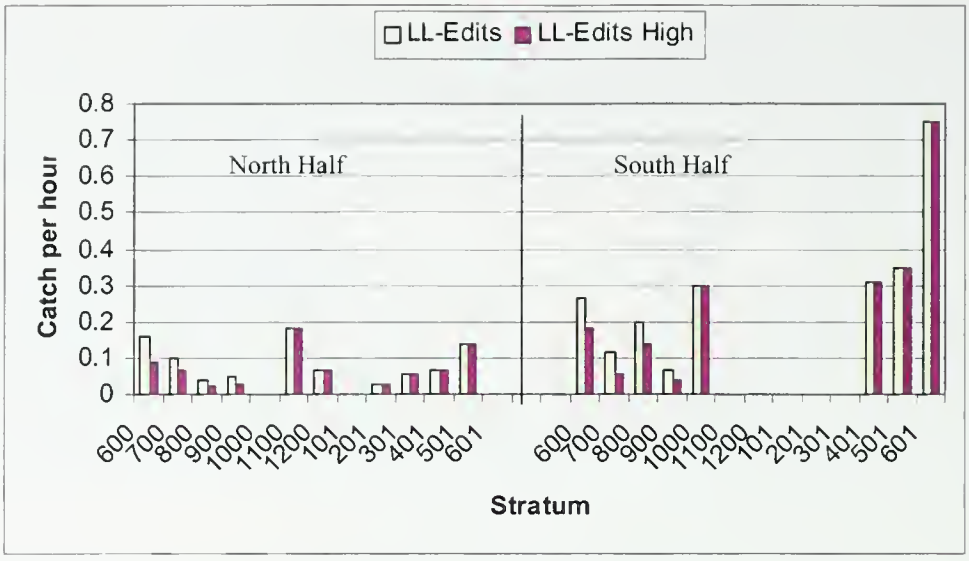

Figure 4. Summary of catch per hour of brown trout (LL), by two analysis methods in the North half (left bar cluster) and South half (right bar cluster) of Hebgen Reservoir during creel survey by stratum from June 12, 2000 ("600") to June 11, 2001 ("601").

Estimated harvest reflected catch rates both seasonally and by species (Table 2). Rainbow trout harvest was estimated at approximately 10,000 fish, versus approximately 3,000 brown trout. Harvest was greatest during periods around ice-on and ice-off.

Creel clerks measured a total of 300 trout during interviews with anglers, including 239 rainbow trout. Brown trout averaged 16.1 inches long, ranging from 12.0 to 22.0 inches. Brown trout weighed 1.46 lbs on average, ranging from 0.74 to 3.37 pounds. Rainbow trout were slightly longer on average at 16.4 inches, ranging from 9.7 to 20.0 inches. Rainbow trout averaged 1.54 lbs, ranging from 0.36 to 2.59 pounds. The length frequency distribution of both species suggests that few juvenile trout are caught in Hebgen Reservoir (Fig. 5). This is similar to gill net catches, suggesting that a majority of rearing occurs in areas inaccessible to reservoir anglers or gill nets (e.g. tributaries, Byorth and Weiss 2002).

Of 236 scale samples suitable for analysis, we aged 43 brown trout, 87 rainbow trout classified as "hatchery" by fin erosion, and 106 rainbow trout classified as "wild" by fin erosion. On average, brown trout grew more slowly than rainbow trout, although by age 5 were nearly the same length as rainbow trout (Fig. 6). Hatchery rainbow trout grew faster than wild rainbow trout, although they reached nearly the same length by age 4.

The only age 1 trout in the creel were rainbow trout classified as hatchery fish. This supports the assertion that most wild trout rear in tributaries (Fig. 7). Age 3 and 4 trout were the most commonly caught year classes for both species. It appears that wild rainbow trout are more common than hatchery trout in older age classes. This may indicate that wild rainbow trout are longer-lived or less susceptible to harvest as younger fish.

Table 2. Summary of estimated harvest of rainbow and brown trout during the Hebgen Reservoir Creel Survey June 12, 2000 and June 11, 2001 by stratum based on two data sets.

Stratum	Estimated Harvest							
	Rainbow Trout				Brown Trout			
	Edits	95%CI	Edits High	95%CI	Edits	95%CI	Edits High	95%CI
6/12/00-	2944.4	1468.2	1974.0	1060.5	1283.9	740.5	835.3	522.9
7/00	1764.4	1787.0	1410.7	1719.9	1073.3	1661.4	1023.1	1659.9
8/00	594.5	526.1	347.7	327.2	166.0	196.7	104.5	124.3
9/00	954.3	642.8	483.4	313.1	126.1	111.4	73.6	71.3
10/00	413.5	722.6	413.5	722.6	325.1	656.0	325.1	656.0
11/00	59.3	81.8	59.3	81.8	23.7	25.4	23.7	25.4
12/00	98.7	72.5	98.7	72.5	32.9	30.3	32.9	30.3
1/01	135.8	137.2	135.8	137.2	0.0	0.0	0.0	0.0
2/01	1099.4	538.6	1099.4	538.6	50.0	51.5	50.0	51.5
3/01	258.0	130.2	258.0	130.2	60.4	53.2	60.4	53.2
4/10	1357.5	124.6	1357.5	124.6	110.4	51.9	110.4	51.9
5/01	1615.5	1105.3	1615.5	1105.3	170.8	753.2	170.8	753.2
-6/11/01	49.5	52.7	49.5	52.7	148.5	158.0	148.5	158.0
Total	11344.8	2853.0	9303.0	2527.5	3571.0	2095.7	2958.2	2531.5

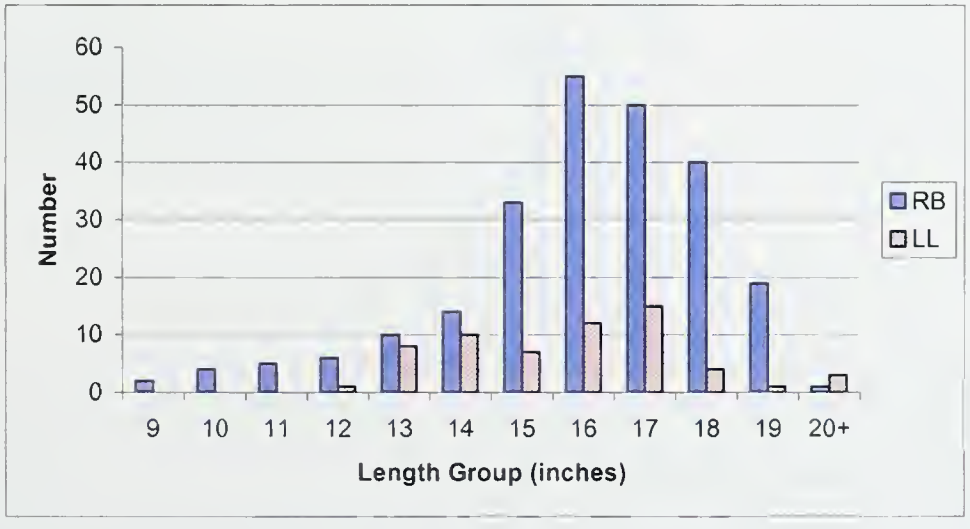

Figure 5. Length-Frequency distribution of rainbow trout (RB) and brown trout (LL) caught by anglers during Hebgen Reservoir Creel Survey, June 12, 2000 to June 11, 2001.

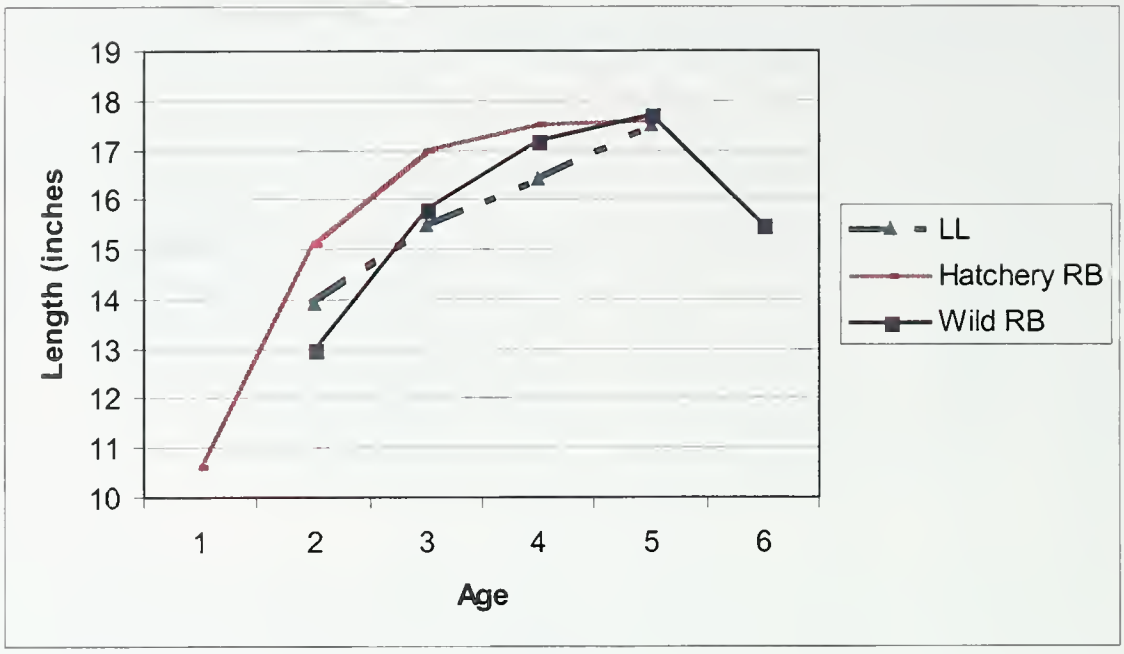

Figure 6. Length at age of brown trout (LL) and rainbow trout (RB) classified as of hatchery or wild origin by fin erosion, derived from scales collected by creel clerks during the Hebgen Reservoir creel survey, 2000-2001.

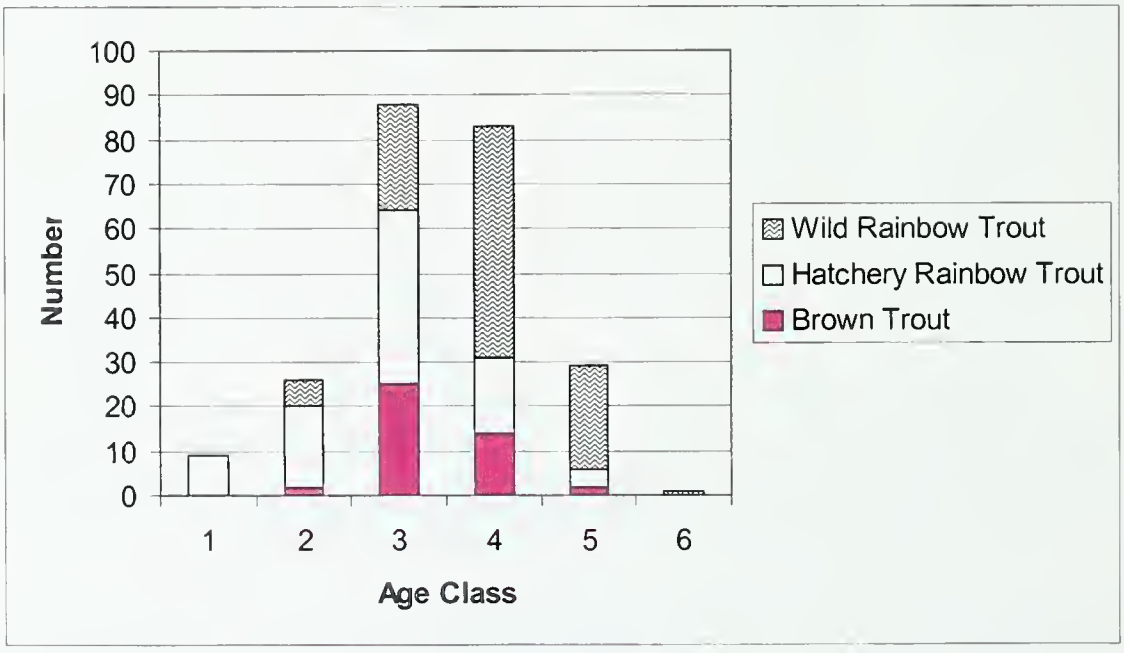

Figure 7. Histogram displaying number of brown trout, hatchery rainbow trout and wild rainbow trout per age class, as derived from scales collected by creel clerks during the Hebgen Reservoir Creel Survey, 2000-2001.

Rainbow Trout Origin

Fin erosion, scale analysis, and tetracycline marks were compared for individual rainbow trout captured by anglers to discern their origin (wild or hatchery). Results were inconsistent between methods. The estimated proportion of rainbow trout of hatchery origin creeled during the survey period ranged from 47% by scale analysis to as low as 3% by tet-mark.

Dorsal fin erosion is a subjective indicator of hatchery origin. In 177 rainbow trout examined for fin erosion, 28% were classified as hatchery fish. In contrast, Byorth and Weiss (2002) report fin erosion rates of 16% and 23% in rainbow trout captured in gill nets in May 2000 and May 2001, respectively.

Scale checks analyzed with the methods of Oswald et al. (1990) led to the highest estimated proportion of hatchery rainbow trout in the creel. Of 177 rainbow trout examined in the creel, scale samples indicated 47% were of hatchery origin. Oswald et al. estimated that 69% of rainbow trout sampled in 1989 were of hatchery origin. Scale analysis is quite subjective as well considering that only 75% of the classifications of the same scales concurred with Oswald et al. (1990).

Table 3 summarizes a comparison between classification of 177 rainbow trout by fin erosion and scale analysis. Agreement between methods was achieved in 41% of the samples for wild fish and 17% of samples for hatchery fish. The highest discrepancy was that 31% of samples classified as wild by fin erosion were classified as hatchery by scale analysis. Only 12% classified by hatchery by fin erosion were classified as wild by scale analysis.

Table 3. Matrix of rainbow trout classifications as hatchery (H) or wild (W) according to fin erosion and scale analysis, collected in the Hebgen Reservoir creel survey June 12, 2000 – June 10, 2001.

Classification by	Classification by		
W	W	72	41
H	H	30	17
W	H	54	31
H	W	21	12

Tet-marks are the most certain indicator of hatchery origin, although marking efficiency is apparently low. Of 90 rainbow trout vertebrae examined, only 3 expressed a tet-mark, indicating that 3.3% of the sample was known to be of hatchery origin. Each of these marks was on a rainbow trout classified as hatchery fish by both fin erosion and scale analysis. Of the same 90 rainbow trout, a total of 29 had dorsal fin erosion. If fin erosion is assumed to be a reliable indicator, then tet-marking efficiency would be assumed to be around 10% (i.e. only 3 of 29 known hatchery fish actually recorded a tet-mark).

Angler Origin

Of 563 anglers responding to residency questions, a majority were not Montana residents. Montana residents represented 39% of anglers interviewed while non-residents were 61%. Anglers came from 15 Montana counties, 23 states and the District of Columbia, and 2 foreign nations (England and Belgium). Gallatin County anglers were the most represented (26.2%), followed by the States of Idaho (25.6%) and Utah (12.6%) (Fig. 8).

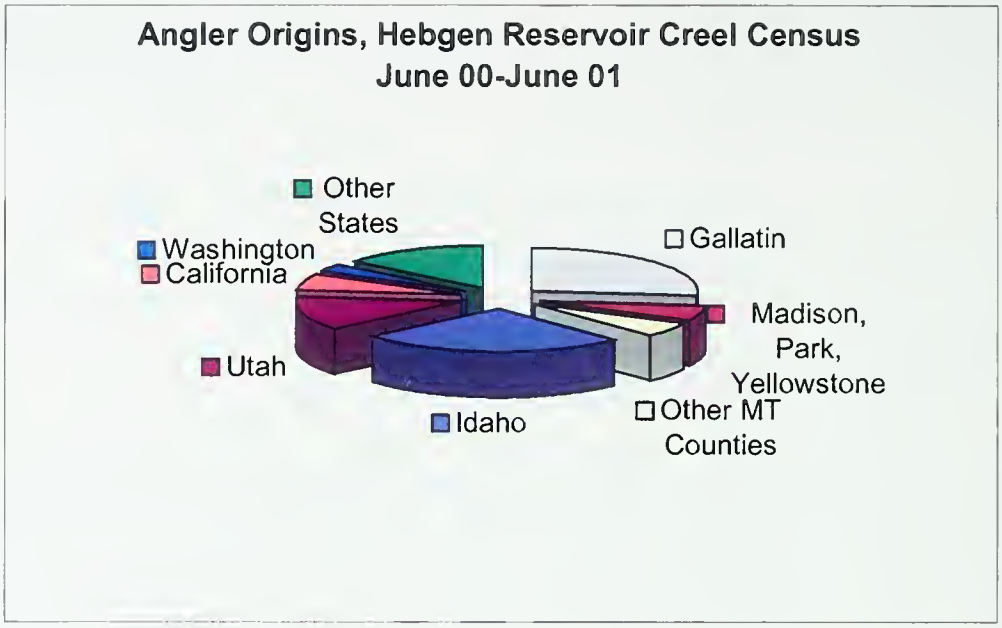

Figure 8. Summary of place of origin for anglers interviewed in the Hebgen Reservoir Creel Survey, June 2000 to June 2001.

Angler Preferences

A total of 564 anglers interviewed by creel clerks indicated the gear that they used the day they were interviewed. Over a third of anglers (37%) use bait, while 32% used some combination of terminal tackle (Fig. 9). Fly fishers represented the second most popular single method.

Of the 560 anglers responding to the question of whether they fished from shore or out of a boat, a majority of anglers claimed they fished from shore (77%) over the course of the entire creel survey. This is almost opposite of results from angler counts which indicated that 71% pressure was from boat anglers. Apparently, a strong interview bias toward shore fisherman resulted from relative ease of locating them for interviews.

Because of long winters, boat access is to Hebgen Reservoir is limited from October to May due to ice. Ice fishing, considered shore fishing, almost exclusively occurred on the North half. During summer and early fall (June through October 2000), 57% of anglers stated that they used a boat while the remainder fished from shore.

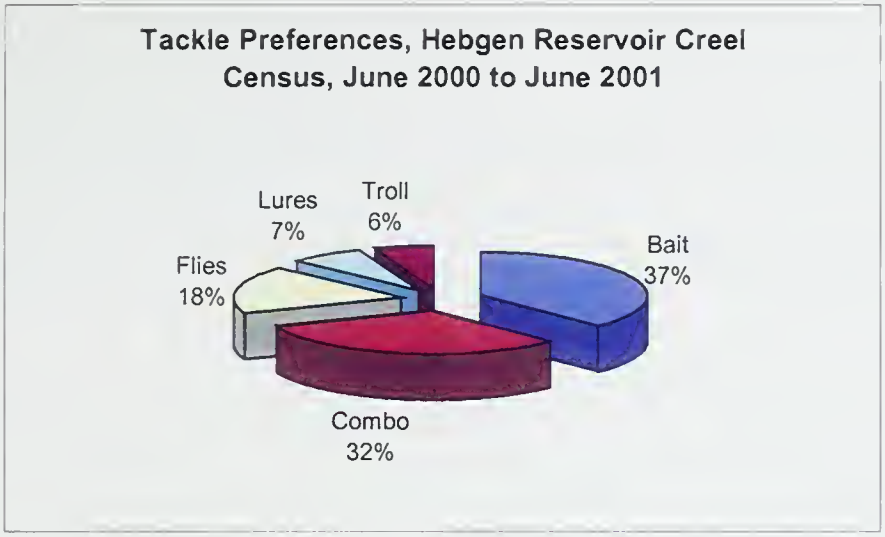

Figure 9. Pie chart illustrating anglers preferences for terminal tackle type during the Hebgen Reservoir Creel Survey, June 2000 – June 2001.

DISCUSSION

Hebgen Reservoir is a popular trout fishery in Southwestern Montana. While the fishery is primarily supported by wild, naturally reproducing rainbow and brown trout, FWP currently stocks approximately 100,000 Eagle Lake rainbow trout annually. While the management goal for Hebgen Reservoir is a self-sustaining wild trout fishery, the affects of ceasing stocking on the fishery are unknown. This creel survey was designed to better understand the Hebgen Reservoir fishery and document the contribution of hatchery rainbow trout to the creel.

Hebgen Reservoir receives most fishing pressure from ice melt in late May to August, reflecting high elevation climate and proximity to Yellowstone National Park. Non-resident anglers comprised over 61% of anglers interviewed. Anglers from Idaho and Gallatin County, Montana, comprised almost half of anglers interviewed. A limited winter ice fishery exists as well. Our estimate of total fishing pressure between June 12, 2000, and June 10, 2001, was 64,811 angler hours (17,694 angler days). This is considerably lower than the 36,751 angler days estimated by McFarland and Meredith (2000) in the biennial mail survey for the 1999 license year (March 1999 to February 2000) and 38,862 angler days in the 2001 license year (March 2001 to February 2002). The direct count method is probably more precise than the biennial mail survey which provides trend information and more direct comparison to other water bodies.

While angling pressure is relatively evenly distributed over the reservoir, the South half was by far dominated by boat anglers based on angling pressure. This could be due to the lack of public boat access on the North half or simply a reflection of fishing conditions. Catch rates of trout were consistently higher on the South side of the reservoir than on the North half. Public boat ramps are limited on the North shore, and additional developments should be investigated.

Catch rates and harvest emphasize the predominance of rainbow trout in the fishery. Catch rates of rainbow trout averaged nearly three times greater than brown trout catch rates. An average of 0.31 rainbow trout were caught per hour overall while brown trout catch rates averaged 0.09 per hour. Rainbow trout catch rates ranged as high as 0.5 fish per hour which could be considered a very good catch rate for trout. Brown trout are less catchable than rainbow trout in general. However, during ice melt in spring and ice formation in fall, catch rates of brown trout peak. Mountain whitefish and Utah chub are common in gill net catches (Byorth and Weiss 2002) but are rare in the anglers' creels.

Size of trout in the creel was very similar between rainbow and brown trout. Brown trout grew more slowly than rainbow trout but reached similar size by age 5. Hatchery rainbow trout grew more quickly than wild rainbow trout, but older, larger wild trout were more common in the creel than hatchery rainbow trout. Age 3 and 4 trout of both species dominated the creel. The lack of Age 1 rainbow trout supports the contention that wild rainbow trout rear in tributaries and are not available to anglers or gill nets. All age 1 rainbow trout captured by anglers were classified as hatchery fish.

The contribution of hatchery vs. wild rainbow trout has been difficult to assess. In this study, we attempted to compare dorsal fin erosion, scale checks, and tet-marks as indicators of rainbow trout origin. Each method has inherent biases. If all methods are considered, the proportion of hatchery rainbow trout in the creel averaged 19%, ranging from 0 to 47% (Table 4). In general, dorsal fin erosion and tet-marks appear to be most strongly correlated (Table 4). Using rainbow trout caught in gill nets either during or immediately before the creel period, dorsal fin erosion indicated 16 to 28% of rainbow trout were of hatchery origin. However, tet-marks indicated 0 to 6% were of hatchery origin. It is clear that tet-marking efficiency is probably less than 10%. Assuming the efficiency is 10%, then 30% of the fish in the creel could have been hatchery rainbow trout.

Scale check marks as an indicator of hatchery origin suggests the highest proportion of hatchery rainbow in the creel (Table 4). However, it appears to be the most subjective and least reliable. Unless more detailed analysis demonstrates specific measurable criteria for classifying a scale "stocking" check, I would not recommend using this method.

Beginning in 2001, at least a third of all stocked rainbow trout have been marked with an adipose clip. This should provide an absolute indicator of hatchery origin. When four year-classes of adipose-clipped rainbow trout are in the population, a scaled back creel survey should be conducted to reassess the contribution to creel and another analysis of the methods of determining hatchery origin. Each rainbow trout with a clipped adipose fin captured in gill nets or creeled by anglers should be classified according to dorsal fin erosion, tet-mark, and scale check to determine the most robust method.
In any case, hatchery rainbow trout are probably contributing up to a third of the rainbow trout to the creel. If this is the case, ceasing stocking may substantially impact catch rates and angler satisfaction. Careful assessment of opportunities to expand wild rainbow trout recruitment should be completed prior to discontinuing stocking. A Montana State

University graduate study is underway which should clarify wild rainbow trout life history and factors limiting wild recruitment.

Table 4. Summary of estimated proportion of hatchery rainbow trout in the population at Hebgen Lake, Montana, by different techniques, 2000 and 2001.

Technique	Source	Estimated % Hatchery
Dorsal Fin Erosion	Creel Survey - this study	28
	Gill nets - May '00	16
	Gill nets - May '01	23
Tet-mark	Creel Survey – this study	3
	Gill nets - May '00	6.3
	Gill nets - May '01	0
Scale Analysis	Creel Survey – this study	47
	Mean (range)	19.2 (0 to 47%)

MANAGEMENT RECOMMENDATIONS

1. Continue stocking until 2007, when 4 year classes of adipose clipped hatchery rainbow trout can be observed and adequately sampled
2. Refine estimates of contribution of hatchery rainbow trout by refining classification methods, comparing methods among adipose clipped rainbow trout caught by anglers and in gill nets
3. Conduct scaled back creel survey, focused on angler interviews and collecting fish data, before and after three years after stocking is discontinued
4. Identify factors limiting wild rainbow trout recruitment and seek opportunities to improve spawning and rearing habitats
5. Seek opportunities to develop public boat ramps on the North Shore of Hebgen Reservoir.

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APPENDIX A

Creel Survey Count Form

Hebgen Creel Survey Angler Count Form

2000-2001

Count Date	Count Time	North or South	Boats		Boat Anglers	Shore Anglers
			Motorized	Non-motorized (tubes)		

Count Date	Count Time	North or South	Boats		Boat Anglers	Shore Anglers
			Motorized	Non-motorized (tubes)		

APPENDIX B

Creel Survey Instructions and Schedule

Hebgen Reservior Creel Survey – 2000-2001

Project Description: Hebgen Reservoir is a popular sport fishery in southwestern Montana, providing an estimated 28,884 angler days in 1997, which ranked as the tenth most fished lake or reservoir in the state. Since the late 1980's, Region 3 fisheries has been attempting to convert this fishery from dependence on hatchery supplementation to a naturally reproducing wild trout population. In the early 1990's, considerable effort was spent investigating the extent of spawning and natural reproduction in tributaries to Hebgen Reservoir. Unfortunately, annual gill netting has not provided an adequate measure of the contribution of wild trout to the fish population and fishery. Additionally, recent information from whirling disease research indicates that further enhancement of wild trout populations through thermal imprinting may have application in the Hebgen basin.

A yearlong creel survey has not been conducted on Hebgen Reservoir. Limited angler interviews have been conducted sporadically since 1967. A full, season long creel survey is necessary to acquire information as to relative contribution of wild trout and hatchery trout to the creel. A summer creel survey would provide a majority of the necessary information , but a winter creel survey would provide a more complete assessment of the fishery. The Summer Creel will be conducted June 2000 through October 2000. Winter creel would extend from November, 2000 through early June, 2001. The creel survey will involve pressure estimates based on actual counts of anglers. This would facilitate actual pressure estimates based on angler counts. Angler interviews would be conducted a minimum of 4 days per week to acquire catch rates, trip length, angler characteristics and attitudes. Direct contact with anglers would also enable us to collect vertebra and scale samples from rainbow trout. Rainbow trout stocked into Hebgen have been tetracycline marked to enable us to distinguish between wild and stocked trout in the creel. The creel survey will also enable us to collect vertebrae over the course of the year to acquire information on growth of stocked and wild fish, determine accuracy of fin erosion as an indicator of stocked versus wild fish, and determine seasonality of stocked and wild trout in the creel.

Hebgen Reservoir is a popular fishery with increasing attention drawn to it: by the West Yellowstone community, Montana residents, and non-resident anglers. This creel survey will be funded through PPL Montana 2188 mitigation funds approved by the fisheries Technical Advisory Committee. This study will more clearly characterize the Hebgen Reservoir fishery, survey angler attitudes, and provide solid data on which to base management decisions.

Creel Survey Design

Angling Pressure Estimates: Angling pressure will be estimated via direct angler counts. Counts for the summer season will be conducted on randomly selected dates stratified in two week periods, beginning June 12 and Ending October 31, 2000. During each two week period during the summer creel, 5 weekdays and two weekend days will be selected at random. On each count date, counts will be conducted in either the morning (6am to 2pm) or evening (2pm to 10pm), also selected at random. To be valid "instantaneous" counts, they must be completed within a one hour period. In order to adequately sample Hebgen Reservoir, it will be divided into north and South halves, the boundary approximated by a line from Watkins Point to "Chub Beach" on the Horse Butte Peninsula. The summer creel survey will involve two creel clerks. Two count starting times will be selected at random within the morning or evening samplings period (i.e. 6 or 7 am, or 2 or 3 pm). Counts will begin on either the North or South half, selected at random. The second count will alternate to the opposite half 2 hours later. Thus, on a given day; counts may begin at 6am North, 8am South, 10am North, and 12pm South. On the North side, a clerk will count anglers from Highway 287 at designated pull-offs from the dam to the Narrows (or vice versa), using a spotting scope or binoculars. The other clerk will count anglers from Horse Butte in the vicinity around rainbow point. Alternately, the south side will be counted from Madison Arms to Edwards Peninsula from the Horse Butte Road. The other clerk will count from the South Fork arm to Spring Creek Campground. Count areas may need adjusting to ensure complete, timely, and accurate counts. Count dates for the summer creel through September 16 , including starting points times are listed in Table 1. Fall and winter schedule will be set by Sept. 1. Weather permitting, clerks may complete angler counts together by boat, if complete, timely counts are feasible. Clerks will count: boat anglers, shore anglers, and non-motorized boats (including float tubes) on the count form.

Angler Interviews: Catch and creel information and angler attitudes will be collected by conducting on-site interviews with anglers. Clerks will focus on completed trips. During non-count hours, clerks will attempt to interview anglers either at marinas and key access points or via boat, if weather permits. Questions will include:

~ Number of anglers in party
~ Time fishing began, and ended, and whether trip is completed, hours fished will be recorded
~ Angler origin, (Montana county, or state of origin)
~ Number of fish caught, kept, and released, by species.
~ Shore, boat, or non-motorized boat
~ Fishing method and terminal tackle
~ Target species

Clerks will request to measure and weigh each creeled fish, take scale samples, and offer to dress rainbow trout in exchange for collecting a vertebrae, which will allow determination of hatchery or wild origin. The clerk will also note whether they feel a fish is wild or hatchery prior to dressing.

During each two week period, one working day will be available for clerks to conduct interviews, tabulate and enter data, or conduct other fisheries work.

STRATUM	DATES			
	WEEKEND	PERIOD, COUNT TIMES	WEEKDAY	STARTING LOCATION (N OR S) AND COUNT TIMES
3. JUNE 12-25	SUN JUN 18 - SAT JUN24	S AM 6,8,10,12 S AM 6,8,10,12,	TUES JUN13 THU JUN15 FRI JUN 16 THU JUN22	N PM 3,5,7,9 S PM 2,4,6,8 N PM 2,4,6,8 N AM 7,9,11,1
4. JUNE 26-JULY 9	SUN JUL 2 SAT JUL 8	N PM 2,4,6,8 S PM 2,4,6,8	MON JUN 26 WED JUN28 MON JUL 3 TUES JUL 4 FRI JUL 7	S PM 2,4,6,8 N AM 7,9,11,1 S PM 2,4,6,8 S AM 6,8,10,12 N PM 3,5,7,9
5. JULY 10- 23	SAT JUL 15 SUN JUL 23	S PM 3,5,7,9 S AM 6,8,10,12	WED JUL 12 FRI JUL 14 WED JUL 17 THU JUL 18 FRI JUL 19	N PM 2,4,6,8 N AM 7,9,11,1 N PM 2,4,6,8 S PM 2,4,6,8 N PM 3,5,,7,9
6. JULY 24-AUG 6	SUN JUL 30 SAT AUG 5	N PM 2,4,6,8 S AM 6,8,10,12	MON JUL 24 WED JUL 26 THU JUL 27 MON JUL 31 TUES AUG 1	S AM 7,9,11,1 N AM 6,8,10,12, S PM 3,5,7,9 S PM 2,4,6,8 N PM 3,5,7,9
7. AUG 7-20	SUN AUG 13 SAT AUG 19	N AM 7,9,11,1 N PM 2,4, 6,8	WED AUG 9 WED AUG 11 TUES AUG 15 WED AUG 16 FRI AUG 18	N AM 6,8,10,12 S AM 6,8,10,12 N PM 3,5,7,9 S PM 3,5,7,9 S AM 7,9,11,1

8. AUG21- SEPT 3	SUN AUG 27 SAT SEP 2	S AM 7,9,11,1, S PM 3,5,7,9	MON AUG 21 THU AUG 24 FRI AUG 25 WED AUG 30 THU AUG 31	N AM 7,9,11,1 S AM 6,8,10,12 N AM 7,9,11,1 S PM 2,4,6,8 N PM 2,4,6,8
9. SEPT 4- 17	SAT SEP 9 SAT SEP 16	N PM 2,4,6,8, N AM 6,8,10,12	MON SEP 4 WED SEP 6 WED SEP 13 THU SEP 14 FRI SEP 15	N PM 3,5,7,9 S PM 3,5,7,9 S PM 2,4,6,8 N AM 7,9,11,1 S AM 6,8,10,12
10. SEPT 18-OCT 1	SAT SEP 23 SUN OCT 1	PM AM	TUE SEP 19 FRI SEP 22 MON SEP 25 WED SEP 27 THU SEP 28	PM AM AM AM PM
11. OCT 2-15	SAT OCT 7 SUN OCT8	PM PM	TUE OCT 3 FRI OCT 6 TUE OCT 10 THU OCT 13 FRI OCT 20	PM PM PM AM PM
12. OCT 16-29	SAT OCT 22 SAT OCT 29	PM PM	MON OCT 16 TUE OCT 17 WED OCT 18 WED OCT 25 FRI OCT 27	PM AM AM PM AM
11. OCT 2-15	SAT OCT 7 SUN OCT8	PM 2 N PM 2 N	TUE OCT 3 FRI OCT 6 TUE OCT 10 THU OCT 13 FRI OCT 20	PM 2 S PM 2 N PM 2 S AM 7 S PM 2 S
12. OCT 16-29	SUN OCT 22	PM 8 N	MON OCT 16 TUE OCT 17 FRI OCT 27	PM 8 S AM 9 N AM 9 S
13. OCT 31-NOV 12	SAT NOV 4	9 AM	MON NOV 6 WED NOV 8 THU NOV 9	8AM 8AM S 7AM
14. NOV 13-26	SAT NOV 25	8AM	THU NOV 16 FRI NOV 17 TUES NOV 21	7AM 8AM 7AM
15. NOV 27-DEC 10	SUN DEC 10	9AM	FRI DEC 1 WED DEC 6 THU DEC 7	9AM S 8AM 9AM
16. DEC 11-24	SUN DEC 17	8AM	THU DEC 14 FRI DEC 15 MON DEC 18	8AM 9AM 8AM S
15. DEC 25 – JAN 7	SAT DEC 31	9AM	MON JAN 1 TUES JAN 2 WED JAN 3	9AM 8AM 8AM S
16. JAN 8 – 21	SUN JAN 21	9AM	THU JAN 11 WED JAN 17 FRI JAN 19	9AM 8AM 9AM S

17. JAN 22 – FEB 4	SUN FEB 4	8AM	FRI JAN 26 MON JAN 29 TUES JAN 30	9AM 8AM S 9AM
18. FEB 5-18	SAT FEB 10	9AM	TUES FEB 6 WED FEB 7 THU FEB 8	8AM 9AM 9AM S
19. FEB 19 – MAR 4	SUN MAR 4	9AM	MON FEB 19 THU FEB 22 FRI MAR 2	9AM 8AM 9AM S
20. MAR 5- MAR 18	SAT MAR 10	7AM	MON MAR 5 THU MAR 8 TUE MAR 13 THU MAR 15	7AM 7AM 7AM 7AM S
21. MAR 19 - APR 1	SUN APR 1	2PM	WED MAR 21 FRI MAR 23 TUE MAR 27 WED MAR 28	2PM 2PM 2PM S 7AM
22. APR 2 – APR 15	SAT APR 7	7AM	TUE APR 3 WED APR 4 FRI APR 6 TUE APR 10	2PM S 2PM 2PM 2PM
23. APR 16 – APR 29	SUN APR 29	7AM	WED APR 18 MON APR 23 TUE APR 24 WED APR 25	2PM 7AM 7AM S 7AM
24. APR 30 – MAY13	SAT MAY 5 SUN MAY 6	2PM N 7AM N	TUE MAY 1 WED MAY 2 FRI MAY 4 WED MAY 9	7AM N 2PM S 7AM N 3PM S
25.MAY14-MAY27	SAT MAY 19 SUN MAY 27	3PM N 7AM S	WED MAY 16 THU MAY 17 TUE MAY 22 WED MAY 23	6AM S 6AM N 7AM S 3PM N
26.MAY28 - JUN 10	SAT JUN 2 SUN JUN 10	3PM N 2PM N	THU MAY 31 WED JUN 6 THU JUN 7 FRI JUN 8	7AM N 7AM S 7AM S 2PM N

APPENDIX C

Creel Survey Interview Form

HEBGEN RESERVOIR CREEL SURVEY
INTERVIEW FORM

ID_ _ _ _ DATE _ _/_ _ / 00 TIME _ _:_ _ DAY (circle) SA SU MO TU WE TH FR NORTH or SOUTH
ANGLERS IN PARTY _ _ _ SHORE OR BOAT (circle) WHERE FROM? _ _ (mt county # or state)

TIME STARTED _ _:_ _ TIME FINISHED_ _ :_ _ TRIP DONE? Y or N WHERE FISHED?_____

TACKLE (circle) flies bait lures troll combo TARGET SPECIES (circle) rb ll mwf uc ct

CATCH DATA (fill out for each angler)

	rainbow trout	brown trout	mountain whitefish	Utah chub	Other (specify):
# Kept					
# Released					
Total caught					

COMMENTS:

****

ID_ _ _ _ DATE _ _/_ _ / 00 TIME _ _:_ _ DAY (circle) SA SU MO TU WE TH FR NORTH or SOUTH

ANGLERS IN PARTY _ _ _ SHORE OR BOAT (circle) WHERE FROM? _ _ (mt county # or state)

TIME STARTED _ _:_ _ TIME FINISHED_ _ :_ _ TRIP DONE? Y or N WHERE FISHED?_____

TACKLE (circle) flies bait lures troll combo TARGET SPECIES (circle) rb ll mwf uc ct

CATCH DATA (fill out for each angler)

	rainbow trout	brown trout	mountain whitefish	Utah chub	Other (specify):
# Kept					
# Released					
Total caught					

COMMENTS: